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Madiwal et al.

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(54) **GAS APPARATUS, SYSTEMS, AND METHODS FOR CHAMBER PORTS**

(71) Applicant: **Applied Materials, Inc.**, Santa Clara, CA (US)

(72) Inventors: **Nagendra V. Madiwal**, Bangalore (IN); **Robert Irwin Decottignies**, Redwood City, CA (US); **Andrew Nguyen**, San Jose, CA (US); **Paul B. Reuter**, Austin, TX (US); **Angela R. Sico**, Round Rock, TX (US); **Michael Kuchar**, Georgetown, TX (US); **Travis Morey**, Austin, TX (US); **Mitchell Disanto**, Georgetown, TX (US)

(73) Assignee: **Applied Materials, Inc.**, Santa Clara, CA (US)

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(51) **Int. Cl.**

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C23C 14/56	(2006.01)
H01L 21/67	(2006.01)
C23C 16/44	(2006.01)

(52) **U.S. Cl.**

CPC ***C23C 14/566*** (2013.01); ***C23C 14/564*** (2013.01); ***C23C 16/4401*** (2013.01); ***H01L 21/6719*** (2013.01); ***H01L 21/67126*** (2013.01); *Y10T 29/49432* (2015.01)

(58) **Field of Classification Search**

CPC H01L 21/67126; H01L 21/6719; C23C 14/564; C23C 16/4401; C23C 14/566; Y10T 29/49432

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,951,770	A	9/1999	Perlov et al.
6,287,386	B1	9/2001	Perlov et al.
6,468,353	B1	10/2002	Perlov et al.
6,575,737	B1	6/2003	Perlov et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2009-038073 2/2009

OTHER PUBLICATIONS

International Search Report and Written Opinion of International Application No. PCT/US2014/057242 mailed Jan. 19, 2015.

(Continued)

Primary Examiner — Gordon R Baldwin

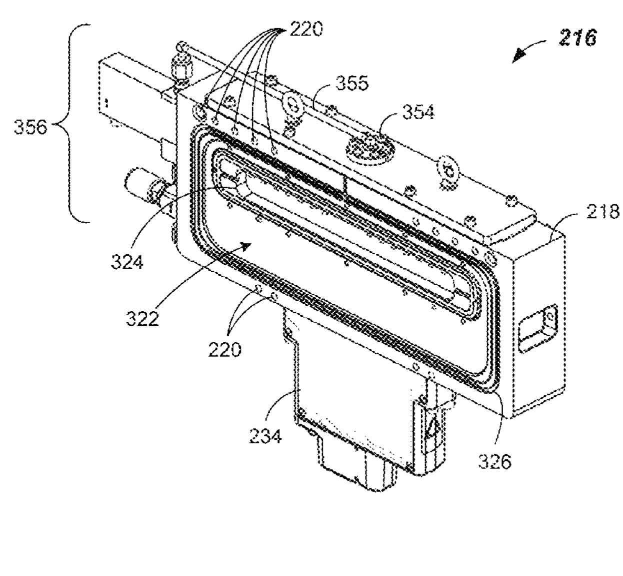
Assistant Examiner — Yuechuan Yu

(74) *Attorney, Agent, or Firm* — Dugan & Dugan, PC

(57) **ABSTRACT**

An electronic device manufacturing system may include a chamber port assembly that provides an interface between a transfer chamber and a process chamber. In some embodiments, the chamber port assembly may be configured to direct a flow of purge gas into a substrate transfer area of the chamber port assembly. In other embodiments, a process chamber and/or the transfer chamber may be configured to direct a flow of purge gas into the substrate transfer area. The flow of purge gas into a substrate transfer area may prevent and/or reduce migration of particulate matter from chamber hardware onto a substrate being transferred between the transfer chamber and a process chamber. Methods of assembling a chamber port assembly are also provided, as are other aspects.

7 Claims, 12 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,916,397	B2	7/2005	Pfeiffer et al.
6,955,197	B2	10/2005	Elliott et al.
7,147,424	B2	12/2006	Weaver
7,299,831	B2	11/2007	Elliott et al.
7,720,655	B2	5/2010	Rice
7,857,570	B2	12/2010	Elliott et al.
2004/0081546	A1	4/2004	Elliott et al.
2005/0072716	A1	4/2005	Quiles et al.
2006/0011140	A1	1/2006	Blahnik et al.
2006/0028596	A1	2/2006	Leung et al.
2007/0059127	A1	3/2007	Guo et al.
2009/0062960	A1	3/2009	Krishnasamy et al.
2009/0108544	A1	4/2009	Sico et al.
2012/0325140	A1	12/2012	Schaller

OTHER PUBLICATIONS

International Preliminary Report on Patentability of International Application No. PCT/US2014/057242 mailed Apr. 7, 2016.

Perlov et al., U.S. Appl. No. 10/193,605, titled: "Method and Apparatus for Improved Substrate Handling", filed Jul. 11, 2002.

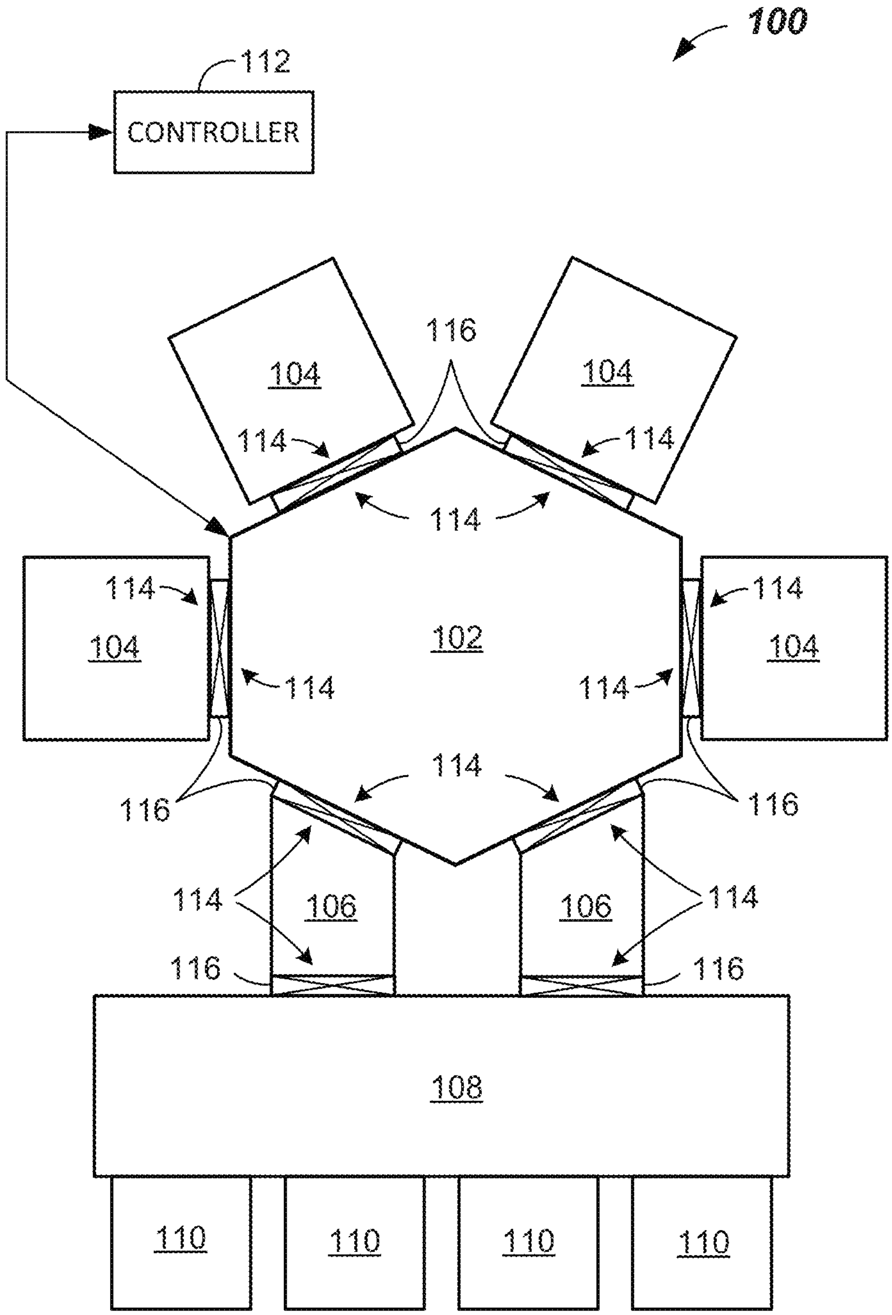

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FIG. 1

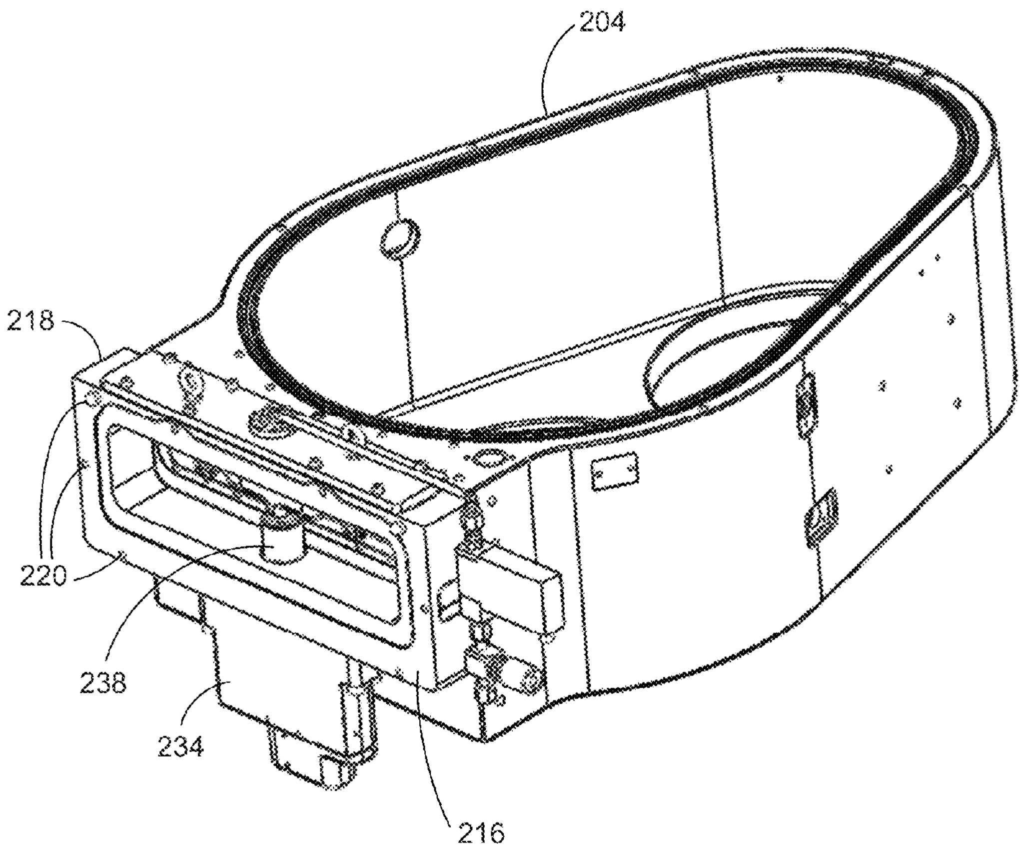
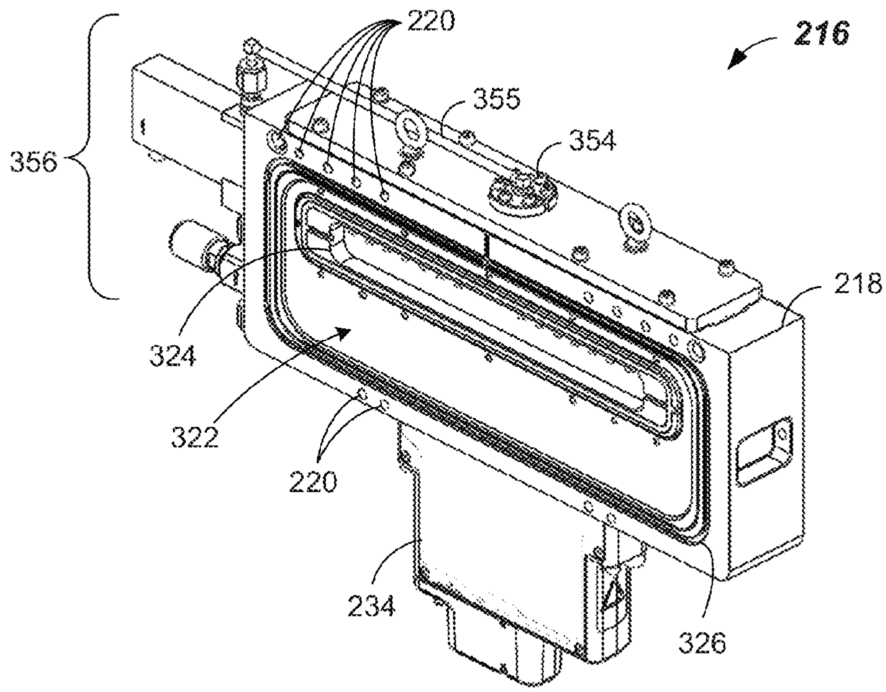


FIG. 2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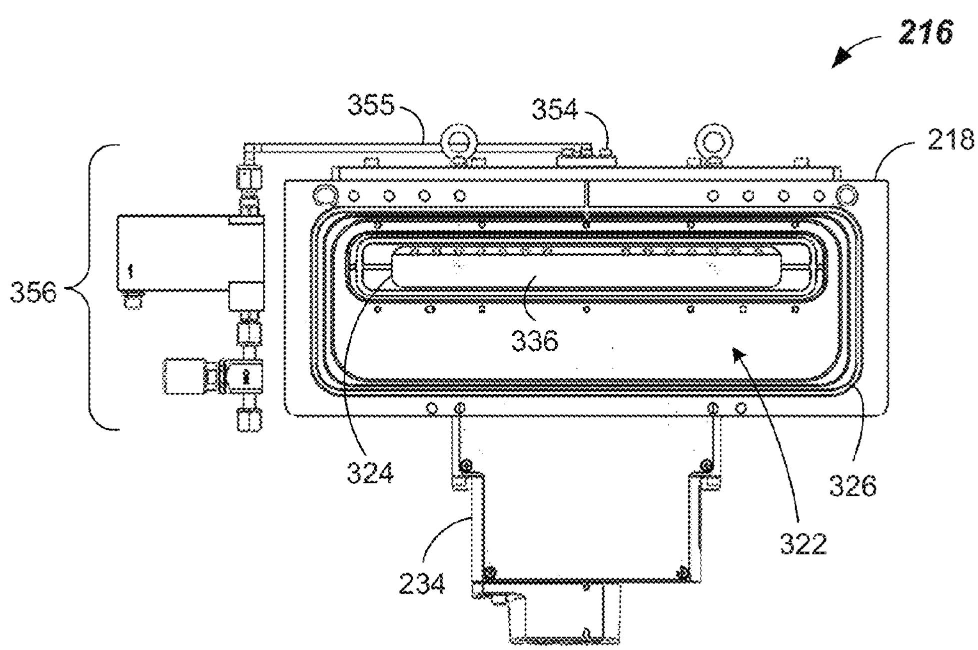
326

FIG. 3A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322
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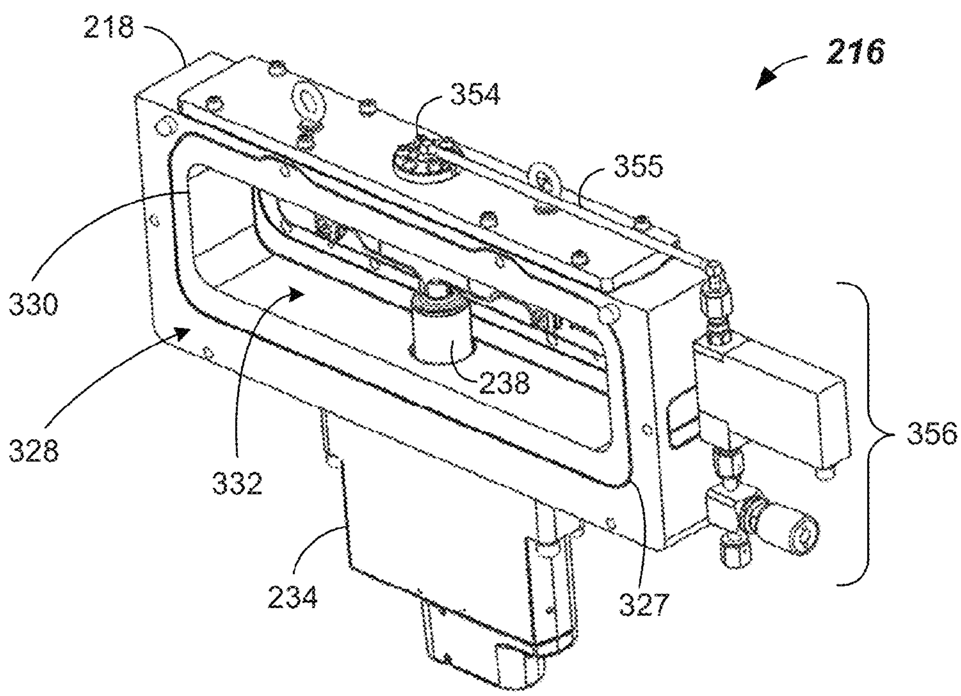
FIG. 3B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218
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330
328
332
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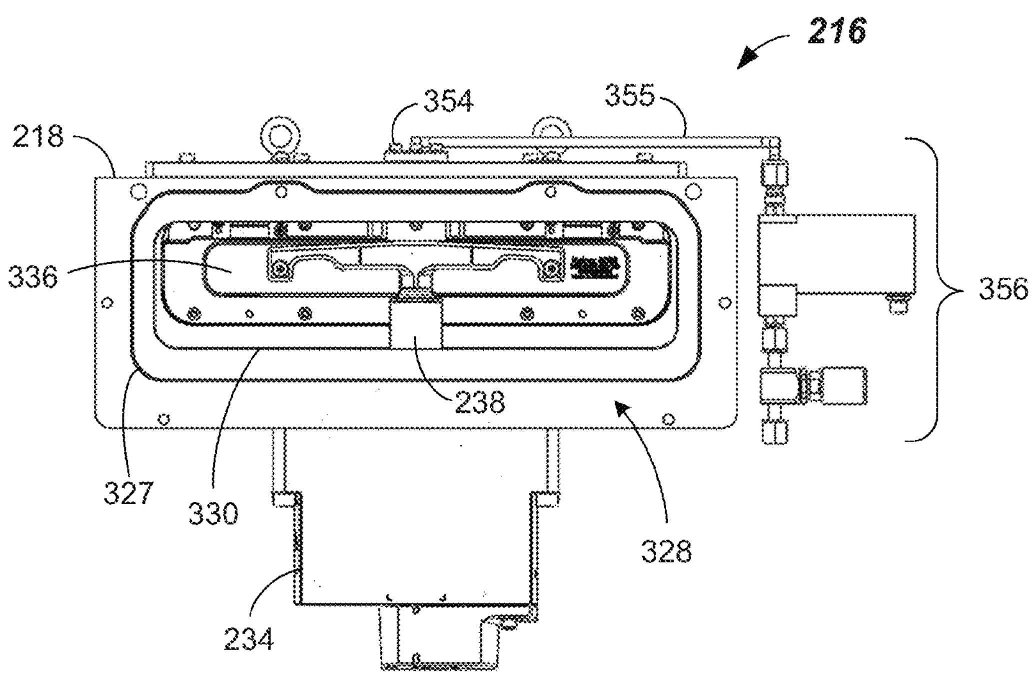
234
327

FIG. 3C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218
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336
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238
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330
328
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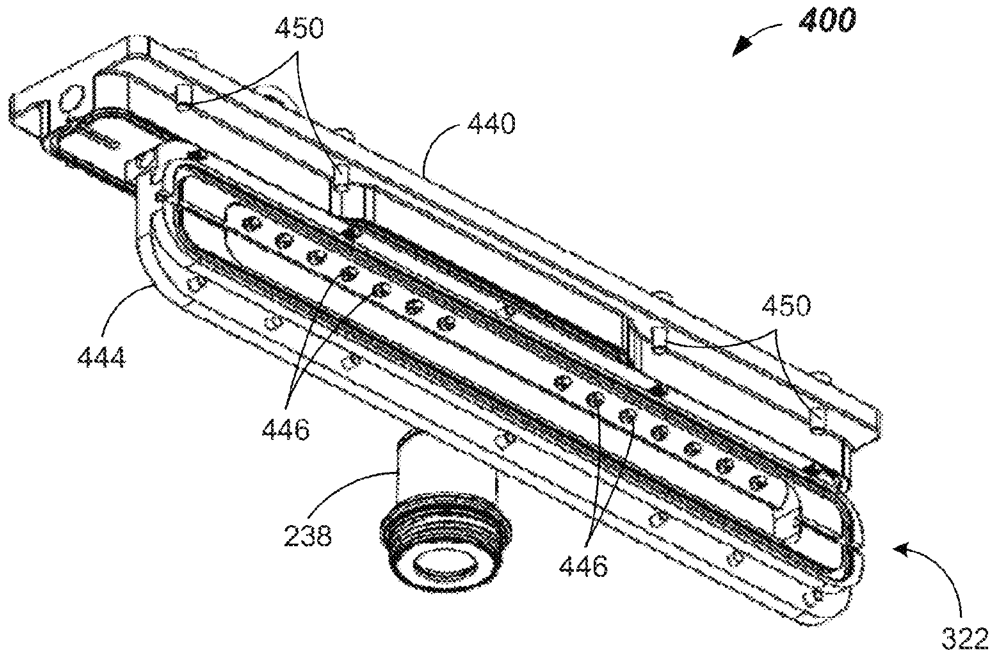
FIG. 3D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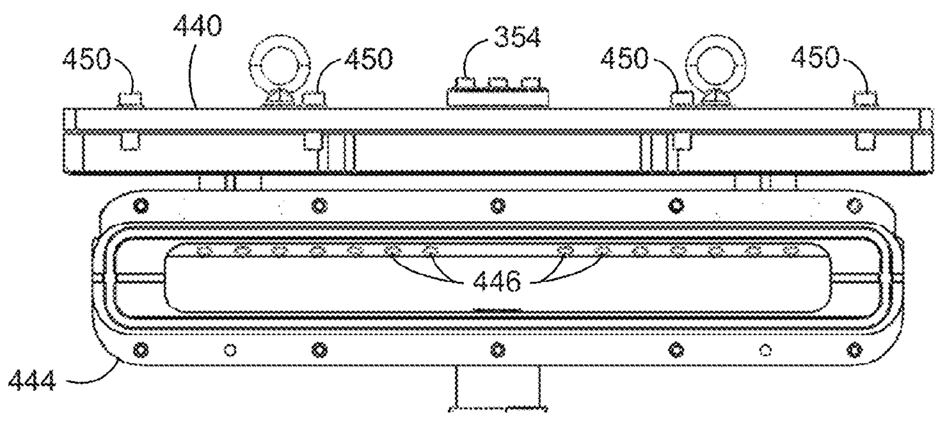
238
446
322

FIG. 4A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450
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444

FIG. 4B

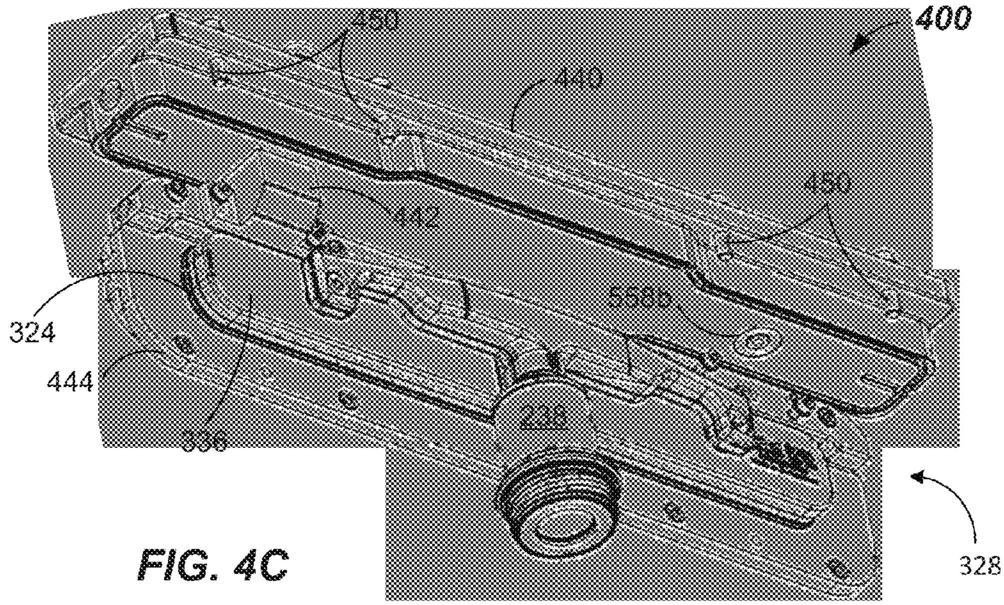

FIG. 4C

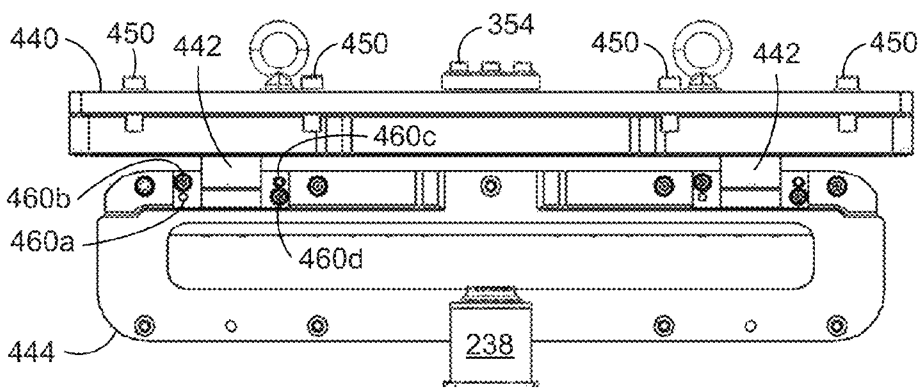

FIG. 4D

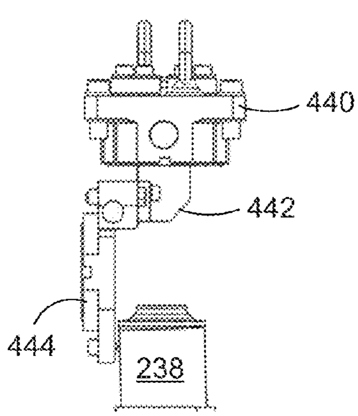

FIG. 4E

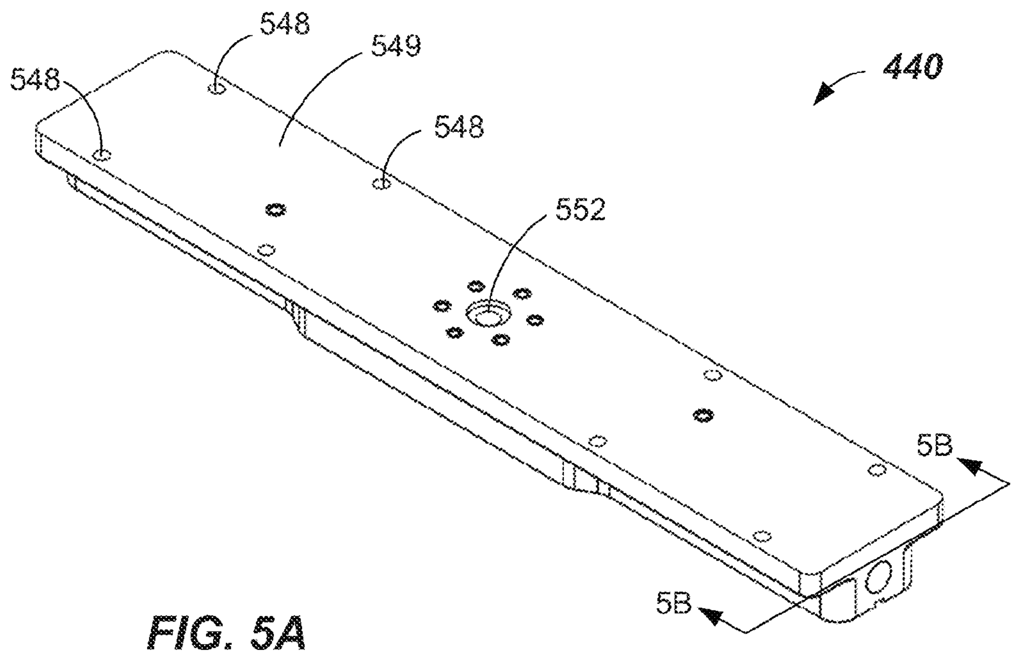

FIG. 5A

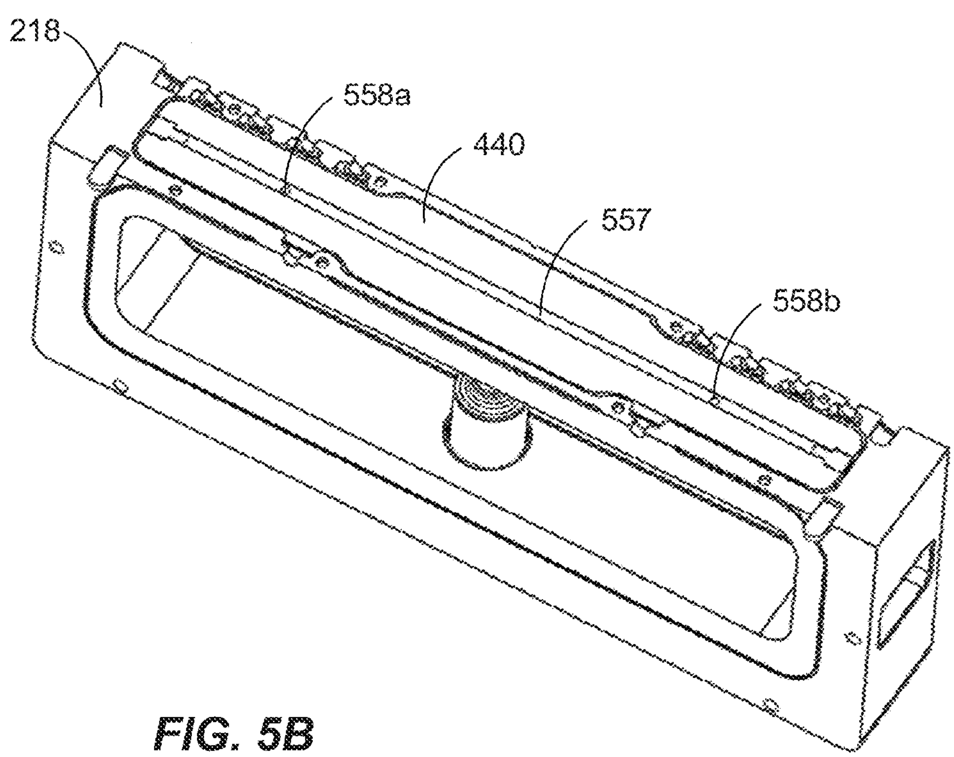

FIG. 5B

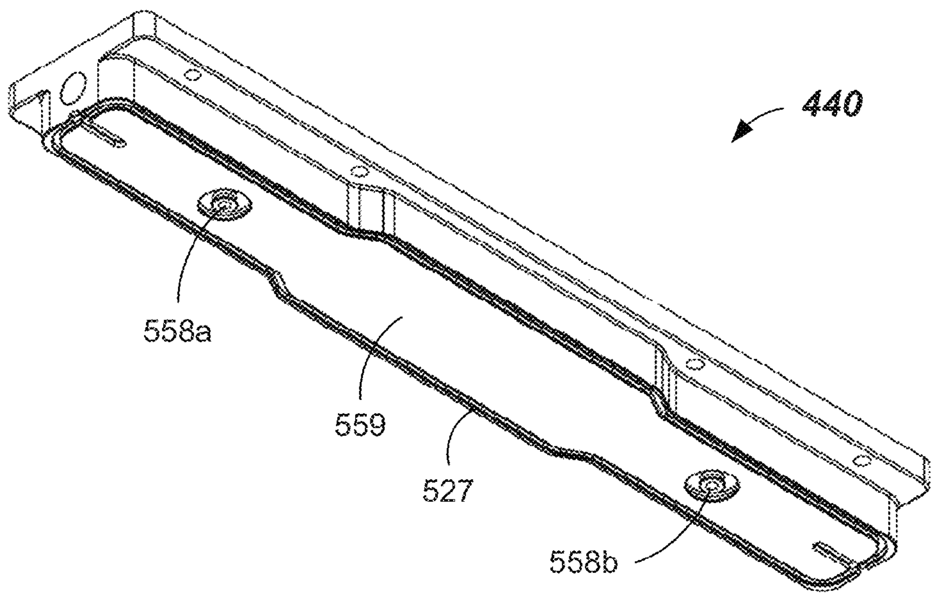

FIG. 5C

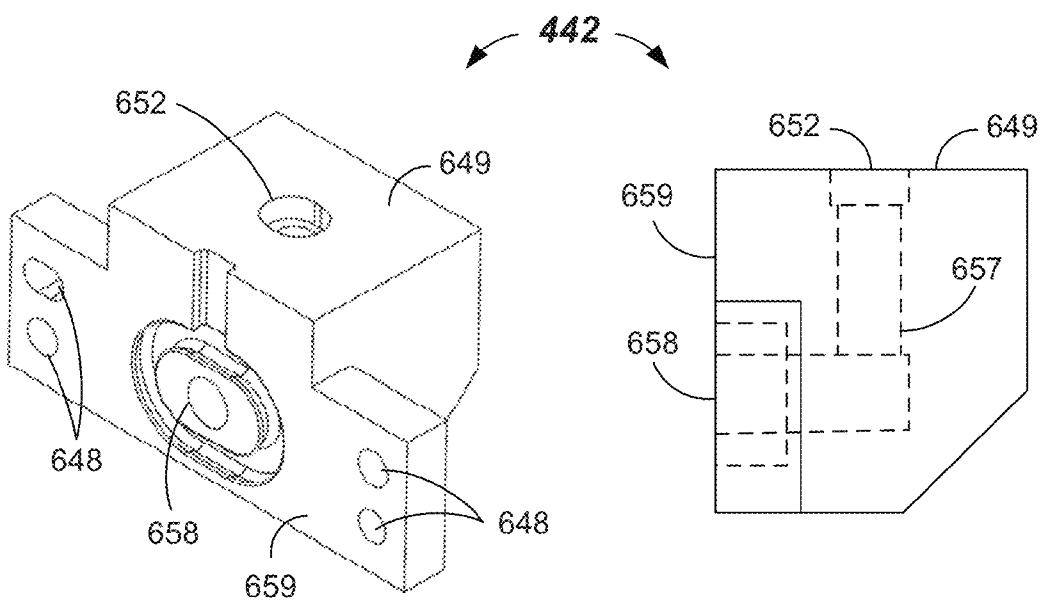

FIG. 6A

FIG. 6B

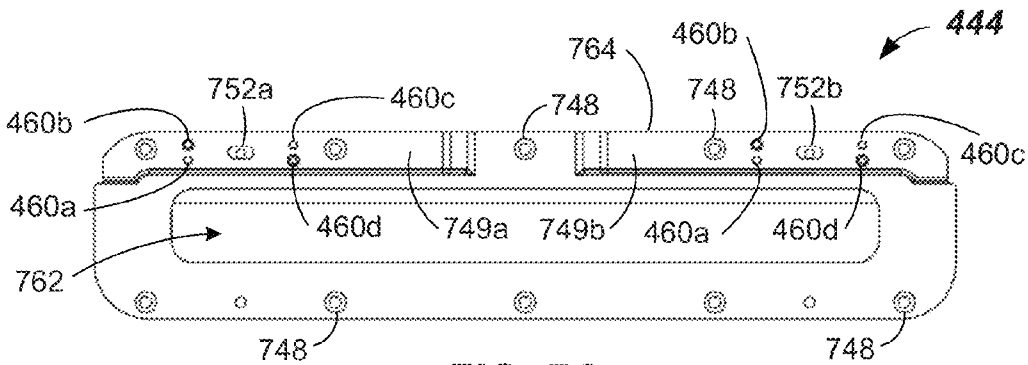

FIG. 7A

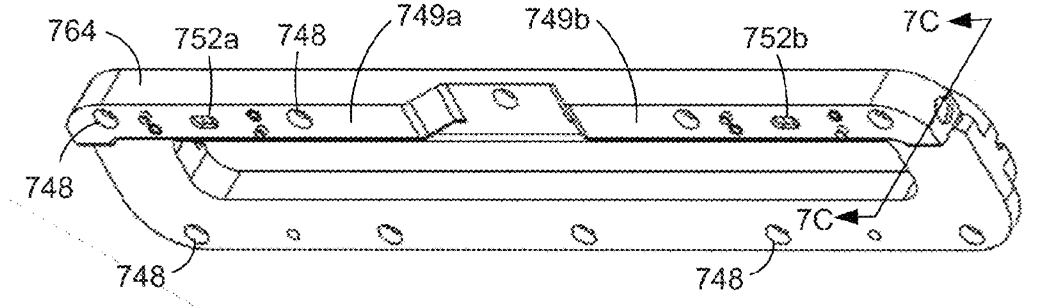

FIG. 7B

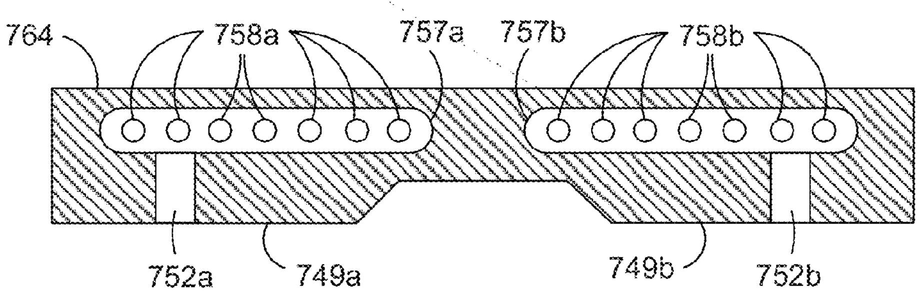

FIG. 7C

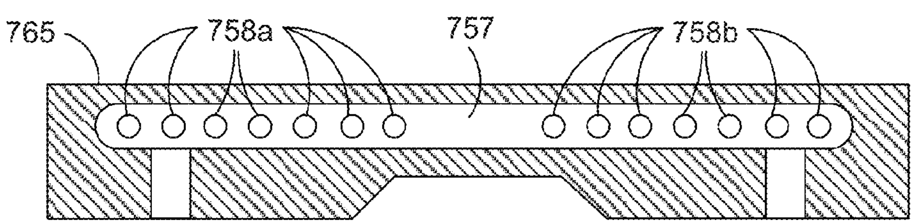

FIG. 7D

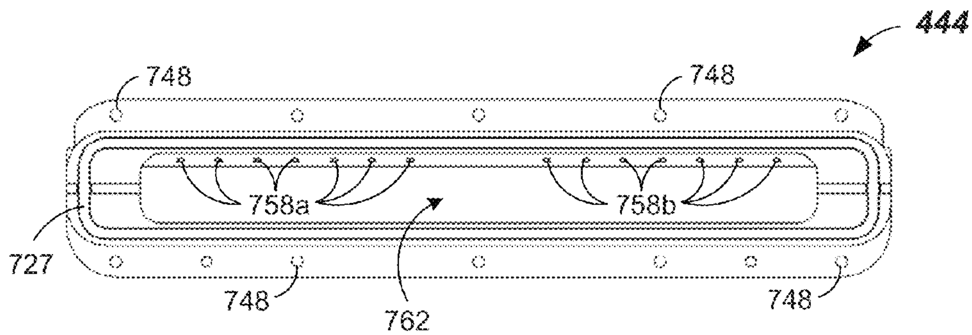

FIG. 7E

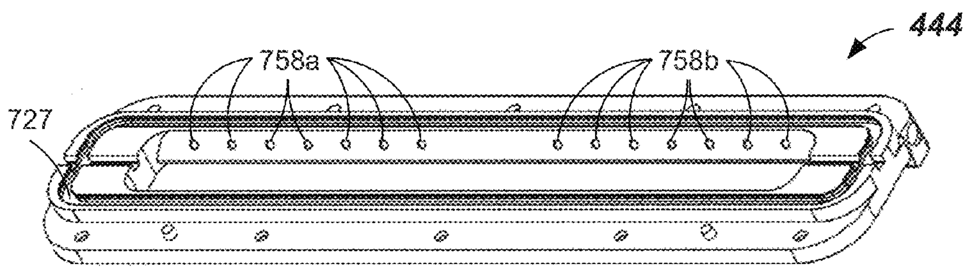

FIG. 7F

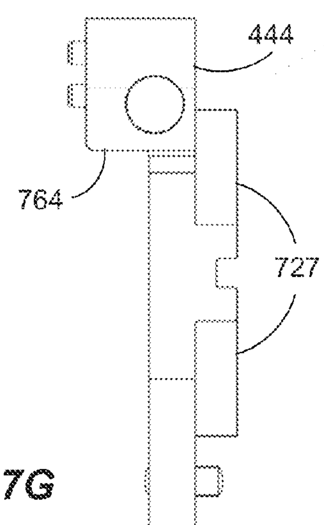

FIG. 7G

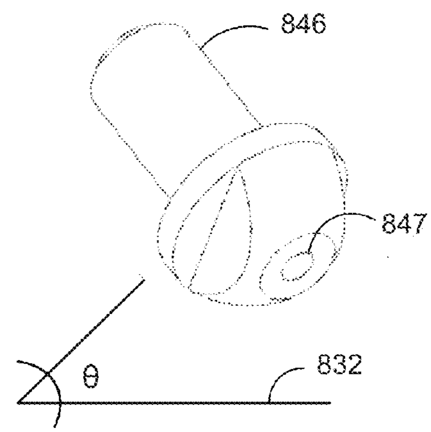

FIG. 8

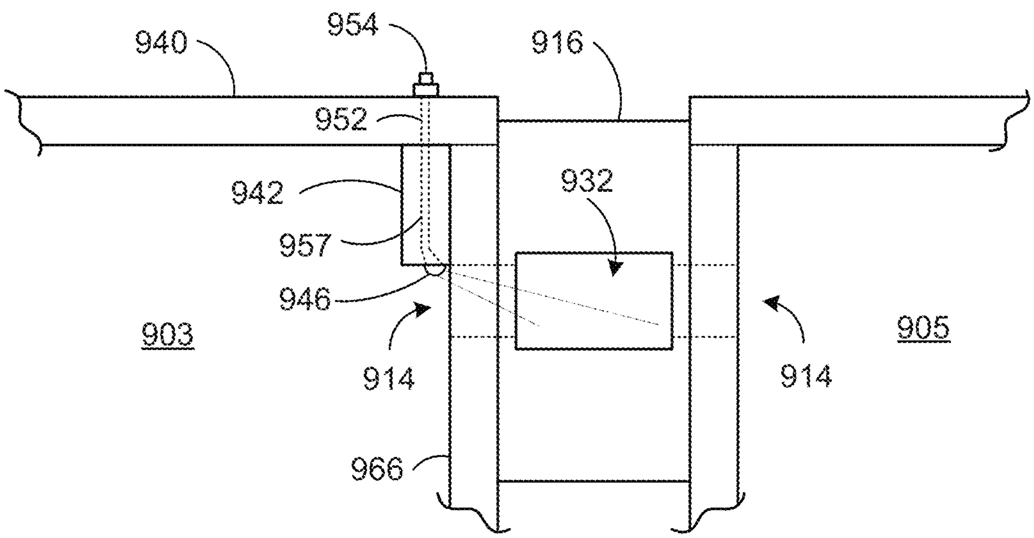

FIG. 9

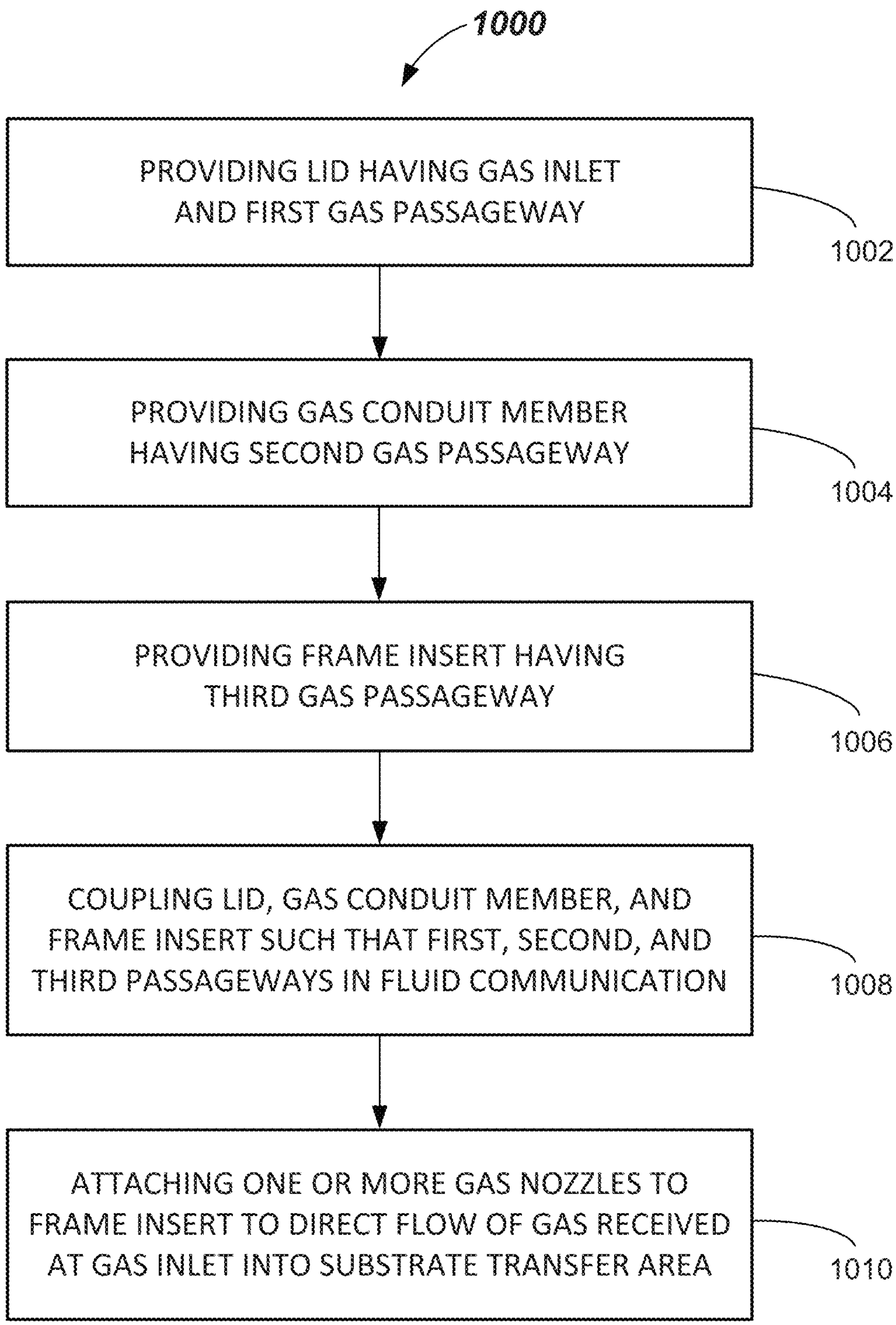
1000
PROVIDING LID HAVING GAS INLET AND FIRST GAS PASSAGEWAY
1002
PROVIDING GAS CONDUIT MEMBER HAVING SECOND GAS PASSAGEWAY
1004
PROVIDING FRAME INSERT HAVING THIRD GAS PASSAGEWAY
1006
COUPLING LID, GAS CONDUIT MEMBER, AND FRAME INSERT SUCH THAT FIRST, SECOND, AND THIRD PASSAGEWAYS IN FLUID COMMUNICATION
1008
ATTACHING ONE OR MORE GAS NOZZLES TO FRAME INSERT TO DIRECT FLOW OF GAS RECEIVED AT GAS INLET INTO SUBSTRATE TRANSFER AREA
1010

FIG. 10

GAS APPARATUS, SYSTEMS, AND METHODS FOR CHAMBER PORTS

FIELD

The invention relates generally to electronic device manufacturing, and more particularly to chamber ports through which substrates are transferred.

BACKGROUND

Conventional electronic device manufacturing systems may include one or more process chambers configured to perform any number of substrate processes including, e.g., degassing, pre-cleaning or cleaning, deposition (e.g., chemical vapor deposition (CVD), physical vapor deposition (PVD), and/or atomic layer deposition), coating, oxidation, nitration, etching (e.g., plasma etching), and the like. Substrates may be semiconductor wafers, glass plates or panels, and/or other workpieces used to make electronic devices or circuit components. Substrates may be transferred between a process chamber and a transfer chamber through a chamber port assembly that may include, e.g., a slit valve. A chamber port assembly provides an interface between chamber ports of a process chamber and a transfer chamber. Undesirable particulate matter from chamber hardware may migrate to a substrate during a transfer of the substrate through a chamber port assembly. The undesirable particulate matter may adversely affect the processing of the substrate, which may render any electronic device and/or circuit component(s) fabricated thereon unusable.

Accordingly, improved apparatus, systems, and methods for transferring a substrate through a chamber port assembly are desired.

SUMMARY

According to a first aspect, a chamber port assembly of an electronic device manufacturing system is provided. The chamber port assembly comprises a lid having a gas inlet formed therein and a first gas passageway extending there through, the first gas passageway in fluid communication with the gas inlet; a gas conduit member having a second gas passageway extending there through, the second gas passageway in fluid communication with the first gas passageway; a frame insert having a third gas passageway in fluid communication with the second gas passageway; and one or more gas nozzles coupled to the frame insert and in fluid communication with the third gas passageway, the one or more gas nozzles configured to direct a flow of gas received at the gas inlet into a substrate transfer area, the substrate transfer area configured to receive a substrate as the substrate is transferred through the chamber port assembly from a first chamber to a second chamber.

According to a second aspect, an electronic device manufacturing system is provided. The electronic device manufacturing system comprises a first chamber configured to receive a substrate therein, a second chamber configured to receive a substrate therein, a chamber port assembly interfacing the first chamber with the second chamber, the chamber port assembly having a substrate transfer area between the first chamber and the second chamber, the substrate transfer area configured to receive a substrate as the substrate is transferred through the chamber port assembly between the first chamber and the second chamber, a gas inlet, a gas conduit member having a gas passageway there through in fluid communication with the gas inlet, and one

or more gas nozzles configured to direct a flow of gas received at the gas inlet into the substrate transfer area.

According to a third aspect, a method of assembling a chamber port assembly for an electronic device manufacturing system is provided. The method comprises providing a lid having a gas inlet formed therein and a first gas passageway extending there through, the first gas passageway in fluid communication with the gas inlet; providing a gas conduit member having a second gas passageway extending there through; providing a frame insert having a third gas passageway extending there through, the frame insert configured to receive one or more gas nozzles such that the third gas passageway is in fluid communication with the one or more gas nozzles; coupling the lid, gas conduit member, and frame insert such that the first, second, and third gas passageways are in fluid communication with each other; and attaching the one or more gas nozzles to the frame insert such that the one or more gas nozzles are configured to direct a flow of gas received at the gas inlet into a substrate transfer area of the chamber port assembly.

Still other aspects, features, and advantages of embodiments of the invention may be readily apparent from the following detailed description wherein a number of example embodiments and implementations are described and illustrated, including the best mode contemplated for carrying out the invention. The invention may also include other and different embodiments, and its several details may be modified in various respects, all without departing from the scope of the invention. Accordingly, the drawings and descriptions are to be regarded as illustrative in nature, and not as restrictive. The invention covers all modifications, equivalents, and alternatives falling within the scope of the invention.

BRIEF DESCRIPTION OF DRAWINGS

The drawings, described below, are for illustrative purposes only and are not necessarily drawn to scale. The drawings are not intended to limit the scope of this disclosure in any way.

FIG. **1** illustrates a schematic top view of an electronic device manufacturing system according to embodiments.

FIG. **2** illustrates a perspective view of a chamber port assembly coupled to a process chamber (with lid removed) according to embodiments.

FIGS. **3**A and **3**B illustrate perspective and orthographic views, respectively, of a first chamber side of the chamber port assembly of FIG. **2** according to embodiments.

FIGS. **3**C and **3**D illustrate perspective and orthographic views, respectively, of a second chamber side of the chamber port assembly of FIG. **2** according to embodiments.

FIGS. **4**A and **4**B illustrate perspective and orthographic views, respectively, of a first chamber side of a subassembly of the chamber port assembly of FIG. **2** according to embodiments.

FIGS. **4**C and **4**D illustrate perspective and orthographic views, respectively, of a second chamber side of the subassembly of FIGS. **4**A and **4**B according to embodiments.

FIG. **4**E illustrates a side orthographic view of the subassembly of FIGS. **4**A-D according to embodiments.

FIG. **5**A illustrates a top perspective view of a lid of the chamber port assembly of FIG. **2** according to embodiments.

FIG. **5**B illustrates a top perspective view of the lid (with top surface removed) of FIG. **5**A attached to a frame of the chamber port assembly of FIG. **2** according to embodiments.

FIG. **5**C illustrates a bottom perspective view of the lid of FIG. **5**A according to embodiments.

FIGS. **6**A and **6**B illustrate perspective and side orthographic views, respectively, of a gas conduit member of the chamber port assembly of FIG. **2** according to embodiments.

FIGS. **7**A and **7**B illustrate orthographic and perspective views, respectively, of a first chamber side of a frame insert of the chamber port assembly of FIG. **2** according to embodiments.

FIGS. **7**C and **7**D illustrate schematic cross-sectional views of alternative embodiments of a portion of the frame insert of FIGS. **7**A and **7**B taken along section line **7**C-**7**C of FIG. **7**B.

FIGS. **7**E and **7**F illustrate orthographic and perspective views, respectively, of a second chamber side of the frame insert of FIGS. **7**A and **7**B according to embodiments.

FIG. **7**G illustrates a side orthographic view of the frame insert of FIGS. **7**A-F according to embodiments.

FIG. **8** illustrates a perspective view of a gas nozzle of the chamber port assembly of FIG. **2** according to embodiments.

FIG. **9** illustrates a schematic cut-away view of a chamber port assembly disposed between two chambers according to embodiments.

FIG. **10** illustrates a flowchart of a method of assembling a chamber port assembly for an electronic device manufacturing system according to embodiments.

DETAILED DESCRIPTION

Reference will now be made in detail to the example embodiments of this disclosure, which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

In one aspect, a chamber port assembly that provides an interface between two chambers, such as, e.g., a process chamber and a transfer chamber of an electronic device manufacturing system, may include gas apparatus configured to direct a flow of gas into a substrate transfer area of the chamber port assembly. Such a flow of gas, which may be a purge gas, such as, e.g., nitrogen, may reduce oxidation and/or corrosion of chamber port assembly parts and sealing interfaces, and/or may reduce particulate matter build-up in the substrate transfer area, and/or may purge the substrate transfer area to reduce and/or prevent migration of particulate matter from the chamber hardware onto a substrate being transferred through the chamber port assembly. In some embodiments, one or more parts of a conventional chamber port assembly may be modified to include, e.g., a gas inlet, one or more gas passageways, and one or more gas nozzles positioned proximate a substrate transfer area. In some embodiments, one or more additional part may be added to a conventional chamber port assembly to provide, e.g., one or more gas passageways in fluid communication with a gas inlet and/or one or more gas nozzles.

In another aspect, either or both chambers coupled to opposite sides of a chamber port assembly may include gas apparatus configured to direct a flow of gas into a substrate transfer area of the chamber port assembly. Either or both of the chambers may include a gas inlet and a gas conduit member coupled to the gas inlet. The gas conduit member may be configured to receive one or more gas nozzles positioned sufficiently proximate to the substrate transfer area to direct a flow of gas into the substrate transfer area. For example, in some embodiments, the gas inlet may be formed in a lid (i.e., top wall) or a side wall of the chamber, and/or the gas conduit member may be positioned and/or mounted on a lid or a side wall to which the chamber port assembly may be coupled.

In other aspects, methods of assembling a chamber port assembly for an electronic device manufacturing system are provided, as will be explained in greater detail below in connection with FIGS. **1-10**.

FIG. **1** illustrates an electronic device manufacturing system **100** in accordance with one or more embodiments. Electronic device manufacturing system **100** may be configured to process multiple substrates concurrently. Substrates may be a semiconductor wafer, glass plate or panel, and/or other workpiece used to make electronic devices or circuit components. Electronic device manufacturing system **100** may include a transfer chamber **102**, a plurality of process chambers **104**, and one or more load lock chambers **106**, each of which may operate at a vacuum pressure. Transfer chamber **102** may have a robot (not shown) configured to transfer substrates to and from each process chamber **104** and each load lock chamber **106**.

Process chambers **104** may each perform a same or a different substrate process including, e.g., deposition (e.g., chemical vapor deposition (CVD), physical vapor deposition (PVD), and/or atomic layer deposition), oxidation, nitration, coating, etching (e.g., plasma etching), polishing, cleaning, lithography, degassing, or the like. Other substrate processes may additionally or alternatively be performed by process chambers **104**. Within each process chamber **104**, one or more substrates may be processed.

Load lock chambers **106** may each be a batch-type or single substrate-type load lock chamber. Load lock chambers **106** may be coupled to a factory interface **108** and may provide a first vacuum interface between factory interface **108** and transfer chamber **102**.

Factory interface **108** may be coupled to one or more FOUPs (front opening unified pods) **110**. Each FOUP **110** may be a container having a stationary cassette for holding multiple substrates. FOUPs **110** may each have a front opening interface configured to be used with factory interface **108**. In other embodiments, any suitable type of pod and/or load port may be used instead of FOUPs **110**. Factory interface **108** may have one or more robots (not shown) configured to transfer substrates in any sequence or direction via linear, rotational, and/or vertical movement between FOUPs **110** and load lock chambers **106**. Electronic device manufacturing system **100** may have other suitable numbers of FOUPs **110**.

A controller **112** may control some or all of the processing and transferring of substrates in and through electronic device manufacturing system **100**. Controller **112** may be, e.g., a general purpose computer and/or may include a microprocessor or other suitable CPU (central processing unit), a memory for storing software routines that control electronic device manufacturing system **100**, input/output peripherals, and support circuits (such as, e.g., power supplies, clock circuits, circuits for driving robots, a cache, and/or the like).

In other embodiments, electronic device manufacturing system **100** may have other suitable numbers and configurations of transfer chamber **102** (including other suitable shapes thereof), process chambers **104**, and/or load lock chambers **106**, each of which may be of conventional design and/or construction.

Transfer chamber **102** and each of process chambers **104** and load lock chambers **106** may have one or more chamber ports **114**. A chamber port **114** may be an opening in a side wall of a chamber configured to allow a horizontally-oriented substrate to pass there through via a robot or other suitable mechanism. Each chamber port **114** may be, e.g., an elongated slot or slit. Chamber ports **114** may have other suitable configurations. Each chamber port **114** may be configured to be coupled to one side of a chamber port assembly **116**.

A plurality of chamber port assemblies **116** may be included in electronic device manufacturing system **100**. A chamber port assembly **116** may be configured to interface one chamber with another chamber at their corresponding chamber ports **114**. For example, as shown in FIG. **1**, a respective chamber port assembly **116** may interface transfer chamber **102** with process chambers **104** and/or load lock chambers **106**. One chamber may be coupled to one side of a chamber port assembly **116**, and the other chamber may be coupled to the opposite side of the chamber port assembly **116**. Chamber port assembly **116** may have a substrate transfer area therein through which horizontally-oriented substrates may be transferred between adjoining chambers via robot or other suitable mechanism. A chamber port assembly **116** may include a slit valve mechanism or other suitable device for opening and closing an opening to the substrate transfer area.

FIG. **2** shows a chamber port assembly **216** coupled to a process chamber **204** (with lid removed) in accordance with one or more embodiments. Chamber port assembly **216** may include a frame **218** that has a plurality of coupling locations **220** (only three are labeled in FIG. **2**) formed on each side of frame **218** that interfaces a chamber. Coupling locations **220** may be, e.g., threaded holes configured to receive a corresponding threaded fastener. For example, chamber port assembly **216** may be coupled to process chamber **204** with a plurality of fasteners, which may have a threaded portion, inserted through corresponding through-holes in a side wall of process chamber **204** and received in a respective plurality of coupling locations **220** formed on frame **218**. One or more O-rings may be disposed between chamber port assembly **216** and process chamber **204** to provide an airtight seal there between. The airtight seal allows substrates to pass between chambers without either chamber losing a vacuum pressure therein. Chamber port assembly **216** may be coupled to process chamber **204** in any other suitable manner.

Chamber port assembly **216** may have a first chamber side **322**, which may be a process chamber side, as shown in FIGS. **3**A and **3**B. First chamber side **322** may be configured to be coupled to, e.g., process chamber **204** as described above and/or to any one of process chambers **104**. First chamber side **322** may have a first opening **324** sized to allow a horizontally-oriented substrate to pass there through via robot or other suitable mechanism. As described above, first chamber side **322** may have a plurality of coupling locations **220** (seven are labeled in FIG. **3**A) formed on frame **218** for coupling to a process chamber. First chamber side **322** may also have one or more O-rings **326** disposed thereon to provide an airtight seal with a process chamber.

Chamber port assembly **216** may have a second chamber side **328**, which may be a transfer chamber side, as shown in FIGS. **3**C and **3**D. Second chamber side **328** may be configured to be coupled to, e.g., transfer chamber **102**. Second chamber side **328** may have one or more O-rings **327** (only one is shown) disposed thereon to provide an airtight seal between chamber port assembly **216** and a transfer chamber. Second chamber side **328** may have a second opening **330** sized to allow a horizontally-oriented substrate to pass there through via robot or other suitable mechanism. Second opening **330** may be larger than first opening **324**. A substrate transfer area **332** may be located between first chamber side **322** and second chamber side **328**, and more particularly, between first opening **324** and second opening **330**. Substrate transfer area **332** may be configured to receive a substrate there through as the substrate is transferred via robot or other suitable mechanism through chamber port assembly **216** from a first chamber to a second chamber, which may be a process chamber and a transfer chamber or vice versa.

Chamber port assembly **216** may include a slit valve mechanism **234**. Slit valve mechanism **234** may include a slit valve door **336** (see FIGS. **3**B and **3**D) and an actuating cylinder **238** for manipulating slit valve door **336**. In some embodiments, slit valve door **336** and actuating cylinder **238** may be located in the substrate transfer area **332**. Slit valve door **336** may be configured to have open and closed positions. In the open position, a substrate may be transferred via robot or other suitable mechanism through substrate transfer area **332** and first and second openings **324** and **330**. In the closed position, slit valve door **336** may seal first opening **324** to provide an airtight boundary between the adjoining chambers coupled to chamber port assembly **216**. In some embodiments, slit valve mechanism **234** may be an L-motion slit valve mechanism. Slit valve mechanism **234** may otherwise be of any suitable and/or conventional construction. Other suitable devices may alternatively be used for opening and closing chamber port assembly **216**.

FIGS. **4**A-E show a sub-assembly **400** of chamber port assembly **216** that may be configured to provide purge gas capability to substrate transfer area **332** in accordance with one or more embodiments. Purge gas capability in and around substrate transfer area **332** may reduce oxidation and/or corrosion of chamber port assembly parts and sealing components, may reduce particulate matter build-up in substrate transfer area **332**, and/or may purge substrate transfer area **332** of particulate matter from chamber hardware that may migrate onto a substrate being transferred through chamber port assembly **216**. Sub-assembly **400** of chamber port assembly **216** may include a lid **440**, one or more gas conduit members **442**, a frame insert **444**, and one or more gas nozzles **446** (only four of which are labeled in each of FIGS. **4**A and **4**B). FIGS. **4**A and **4**B show lid **440**, frame insert **444**, and gas nozzles **446** from first chamber side **322** of chamber port assembly **216**, while FIGS. **4**C, **4**D, and **4**E show lid **440**, gas conduit members **442**, and frame insert **444** from second chamber side **328** of chamber port assembly **216**.

As best shown in FIG. **4**C, slit valve door **336** may abut frame insert **444** and seal first opening **324** when slit valve door **336** is in the closed position. That is, slit valve door **336** may be seated in, and biased against, frame insert **444** by actuating cylinder **238** of slit valve mechanism **234** to create an airtight seal at first opening **324**.

FIGS. **5**A-C show lid **440**, which in some embodiments, may be seated on or butted against each of gas conduit members **442** (note that in FIG. **4**C only one gas conduit member **442** is shown). In other words, lid **440** may not be mechanically fastened or attached directly to gas conduit members **442**. Instead, as shown in FIG. **5**A, lid **440** may have a plurality of through-holes **548** (of which only three are labeled) formed in a top surface **549** of lid **440**. Through-holes **548** may each be configured to receive a fastener **450** (see FIGS. **4**A-E) for attaching lid **440** to frame **218** of chamber port assembly **216** (see FIG. **5**B). Fasteners **450** may be, e.g., threaded screws or bolts. As shown in FIG. **5**C, an O-ring **527** seated in a groove around the perimeter of a bottom surface **559** of lid **440** may be used to provide an airtight seal with frame **218**. Lid **440** may be secured to frame **218** in any other suitable manner. In other embodiments, lid **440** may alternatively or additionally be mechanically fastened or attached directly to gas conduit members **442**.

As also shown in FIG. **5**A, lid **440** may have a gas inlet **552** formed in top surface **549**. Gas inlet **552** may be configured to couple to, as shown in FIGS. **3**A-D, a gas inlet connector **354**, which in turn may be coupled to a gas line **355**, which may be coupled to gas delivery apparatus **356**. Some or all of gas inlet connector **354**, gas line **355**, and gas apparatus **356** may be of conventional design and/or construction. In some embodiments, gas delivery apparatus **356** may be configured to deliver a purge gas, such as, e.g., nitrogen, to chamber port assembly **216**, as described further below.

FIG. **5**B shows lid **440** (with top surface **549** removed along section line **5**B-**5**B of FIG. **5**A) attached to frame **218**. Lid **440** may have a gas passageway **557** extending internally and longitudinally through lid **440**. Gas passageway **558** may be in fluid communication with gas inlet **552** and gas outlets **558***a* and **558***b*. As shown in FIG. **5**C, gas outlets **558***a* and **558***b* may extend through bottom surface **559** of lid **440**. Lid **440** may be made of aluminum, stainless steel, one or more titanium-based materials, and/or any other suitable material.

FIGS. **6**A and **6**B show a gas conduit member **442** in accordance with one or more embodiments. In some embodiments, one or more gas conduit members **442** may be disposed between lid **440** and frame insert **444**, as perhaps best shown in FIG. **4**E. Gas conduit member **442** may be attached to frame insert **444** with bolts or screws. For example, gas conduit members **442** may have a plurality of through-holes **648** configured to align with coupling locations **460***a-d* formed on frame insert **444** (see, e.g., FIG. **4**D). Coupling locations **460***a-d* may each be threaded holes configured to receive a threaded bolt or screw, which may be, e.g., a hex-headed bolt or screw that can be installed and removed with a stubbed hex-headed key tool for convenience. In some embodiments, e.g., two of four coupling locations **460***a* and **460***c* may be alignment dowels configured to be received in two of four aligned through-holes **648**, wherein bolts or screws may be fastened through the other two through-holes **648** into aligned coupling locations **460***b* and **460***d*. Gas conduit member **442** may be attached to frame insert **444**, or any other suitable part of chamber port assembly **216**, in any other suitable manner. Gas conduit member **442** may be of other suitable shapes and/or configurations. Gas conduit member **442** may be made of aluminum, stainless steel, a polyimide-based plastic such as, e.g., Vespel® by DuPont™, and/or any other suitable material.

Gas conduit member **442** may have a gas inlet **652**, a gas outlet **658**, and a gas passageway **657** extending internally through gas conduit member **442**. Gas passageway **657** may connect gas inlet **652** to gas outlet **658**. Gas inlet **652** may be formed in a top surface **649** of gas conduit member **442**, and gas outlet **658** may be formed in side surface **659** of gas conduit member **442**. Gas passageway **657** may be in fluid communication with gas passageway **557** of lid **440** upon lid **440** being coupled to gas conduit member **442**. That is, e.g., upon lid **440** being seated on or butted against gas conduit member **442**, gas inlet **652** may be coupled to one of gas outlets **558***a* or **558***b* (using any suitable connectors, O-rings, etc.) such that a sealed gas connection is formed there between. In some embodiments, as shown in FIG. **4**D, two gas conduit members **442** are included in sub-assembly **400**. Other embodiments may have one gas conduit member **442** or more than two gas conduit members **442**.

FIGS. **7**A-F show frame insert **444** of chamber port assembly **216** in accordance with one or more embodiments. FIGS. **7**A and **7**B show frame insert **444** from second chamber side **328**, and FIGS. **7**E and **7**F show frame insert **444** from first chamber side **322**. FIG. **7**G shows a side view of frame insert **444**. Frame insert **444** may have an opening **762** sized substantially identically as first opening **324**. Frame insert **444** may be coupled to frame **218** of chamber port assembly **216**. Frame insert **444** may have a plurality of through-holes **748** (of which only four are labeled in each of FIGS. **7**A, **7**B, and **7**E). Through-holes **748** may be configured to receive fasteners there through for fastening to corresponding aligned coupling locations (not shown) on frame **218**. The fasteners may be, e.g., hex-headed bolts or screws that can be installed and removed with a stubbed hex-headed key tool for convenience. In some embodiments, frame insert **444** may be removable and replaceable without having to remove chamber port assembly **216** from any attached chambers. In some embodiments, frame insert **444** may be removed and/or replaced by first removing lid **440**. Frame insert **444** may include a groove **727** (FIG. **7**E) configured to receive an O-ring therein to provide an airtight seal with frame **218**. Frame insert **444** may be attached to frame **218**, and/or any other suitable part of chamber port assembly **216**, in any other suitable manner. Frame insert **444** may be made of anodized aluminum or any other suitable material.

Frame insert **444** has a top portion **764** to which a pair of gas conduit members **442** may be attached at respective coupling locations **460***a-d*, as described above. Top portion **764** may have gas inlets **752***a* and **752***b* formed in respective side surfaces **749***a* and **749***b* of top portion **764**. Gas inlets **752***a* and **752***b*, which may be identical to each other, may each be configured to couple with a gas outlet **658** of a respective gas conduit member **442**. That is, upon attachment of a gas conduit member **442** to frame insert **444** at one of side surfaces **749***a* or **749***b*, gas inlet **752***a* or **752***b* may be coupled to gas outlet **658** (using any suitable connectors, O-rings, etc.) such that a sealed gas connection is formed there between.

As shown in FIG. **7**C, top portion **764** of frame insert **444** may include a first plurality of gas outlets **758***a* and a gas passageway **757***a* extending internally and longitudinally through a first section of frame insert **444**. Gas passageway **757***a* may connect gas inlet **752***a* to each of gas outlets **758***a*. Top portion **764** of frame insert **444** may also include a second plurality of gas outlets **758***b* and a gas passageway **757***b* extending internally and longitudinally through a second section of frame insert **444**. Gas passageway **757***b* may connect gas inlet **752***b* to each of gas outlets **758***b*. Each of gas outlets **758***a* and **758***b* may be identical to each other. Although seven gas outlets **758***a*/**758***b* are shown in each section, other embodiments may have any suitable number of gas outlets **758***a*/**758***b* in each section of frame insert **444**.

Upon assembly of lid **440** and frame insert **444** with a first gas conduit member **442** (e.g., to gas inlet **752***a*), as described above, gas passageway **757***a* of frame insert **444** may be in fluid communication with gas passageway **657** of the first gas conduit member **442** and gas passageway **557** of lid **440**. Similarly, upon assembly of lid **440** and frame insert **444** with a second gas conduit member **442** (e.g., to gas inlet **752***b*), as described above, gas passageway **757***b* may be in fluid communication with gas passageway **657** of the second gas conduit member **442** and gas passageway **557** of lid **440**. The assembly of lid **440** and frame insert **444** with first and second gas conduit members **442** may occur concurrently.

In alternative embodiments, as shown in FIG. **7**D, frame insert **444** may have a top portion **765** that includes gas outlets **758***a* and **758***b* and a single gas passageway **757** extending internally and longitudinally through frame insert **444**. Gas passageway **757** may connect gas inlets **752***a* and **752***b* to each of gas outlets **758***a* and **758***b* such that all are in fluid communication with each other. Although 14 total gas outlets **758***a* and **758***b* are shown in top portion **765**, other embodiments may have any suitable number of gas outlets **758***a* or **758***b* in top section **765** of frame insert **444**. Top portion **765** may otherwise be similar or identical to top portion **764**. Upon assembly of frame insert **444** with one or two gas conduit members **442** and lid **440** as described above, gas passageway **757** may be in fluid communication with gas passageway **657** of one or both of gas conduit members **442** and gas passageway **557** of lid **440**.

Each of gas outlets **758***a* and **758***b* of frame insert **444** may be configured to receive a gas nozzle **446**. An embodiment of gas nozzle **446** may be, e.g., gas nozzle **846** of FIG. **8**. Gas nozzle **846** may be made of, e.g., a polyimide-based plastic such as, e.g., Vespel® by DuPont™. Gas nozzle **846** may alternatively be made of any other suitable material(s). Gas nozzle **846** may be inserted into a gas outlet **758***a* or **758***b* and held in place by an adhesive or by friction. Gas nozzle **846** may otherwise be coupled or fastened to a gas outlet **758***a* or **758***b* in any suitable manner. In some embodiments, gas nozzles **846** may be received in frame insert **444** such that they are disposed substantially in substrate transfer area **332** and/or above a bottom surface of substrate transfer area **332**. The gas nozzles **846** coupled to frame insert **444** may oriented and/or arranged to direct gas in various directions and/or dispersal and/or diffusion patterns into and/or around substrate transfer area **332**. Although shown with one nozzle opening **847**, some embodiments of gas nozzle **846** may have multiple nozzle openings. In some embodiments, such as shown in FIG. **8**, e.g., gas nozzles **846** may be arranged with respect to a bottom surface **832** of substrate transfer area **332** at an angle θ, which may be about 32 degrees. In other embodiments, angle θ may have other suitable values. One or more gas nozzles **846** coupled to frame insert **444** may be in fluid communication gas passageway **757***a* or gas passageway **757***b*. In the alternative embodiments of FIG. **7**D, one or more gas nozzles **846** coupled to frame insert **444** may be in fluid communication gas passageway **757**.

Upon assembly of subassembly **400** (including lid **440**, at least one gas conduit member **442**, frame insert **444**, and one or more gas nozzles **846**), the one or more gas nozzles **846** may be configured to direct a flow of gas received at gas inlet **552** of lid **440** into substrate transfer area **332** of chamber port assembly **216**. The gas may be a purge gas, such as, e.g., nitrogen, for reducing oxidation and/or corrosion of chamber port assembly parts and sealing interfaces, reducing particulate matter build-up in substrate transfer area **332**, and/or reducing migration of particulate matter from chamber hardware onto a substrate being transferred through substrate transfer area **332** of chamber port assembly **216**.

In some embodiments, chamber port assembly **216** may be used with, e.g., any etch process chamber included in a Centura AP or Centris electronic device manufacturing system available from Applied Materials, Inc., of Santa Clara, Calif.

FIG. **9** shows a first chamber **903** coupled to a second chamber **905** via a chamber port assembly **916**, which may be of conventional design and/or construction. Chamber port assembly **916** may have a substrate transfer area **932** configured to receive a substrate there through as the substrate is transferred through chamber port assembly **916** from one of first and second chambers **903** or **905** to the other of first and second chambers **903** or **905**. First and second chambers **903** and **905** may each be a transfer chamber, such as, e.g., transfer chamber **102**, or a process chamber, such as, e.g., a process chamber **104** or **204**. First and second chambers **903** and **905** may each have a chamber port **914** configured to interface with a respective chamber side of chamber port assembly **916**. Each chamber port **914** may be, e.g., an elongated opening in a side wall of the chamber. Either or both of first and second chambers **903** and **905** may be configured to direct a flow of gas into substrate transfer area **932**, as now described in connection with first chamber **903**.

In some embodiments, first chamber **903** may include a gas inlet **952** formed in a lid **940** of first chamber **903**. In other embodiments, gas inlet **952** may be formed in a side wall of first chamber **903**. Gas inlet **952** may be configured to be coupled to a gas inlet connector **954**, which in turn may be configured to be coupled to a gas line and gas delivery apparatus, such as, e.g., gas line **355** and gas delivery apparatus **356** (FIG. **3**). First chamber **903** may also include a gas conduit member **942**, which may be mounted to lid **940** and/or side wall **966** of first chamber **903**. Gas conduit member **942** may have a gas passageway **957** extending internally there through and in fluid communication with gas inlet **952**. Gas conduit member **942** may also have one or more gas nozzles **946** in fluid communication with gas passageway **957**. Gas conduit member **942** and/or the one or more gas nozzles **946** may be disposed proximate to a chamber port **914** of first chamber **903**, as shown. The one or more gas nozzles **946** may be configured to direct a flow of gas received at gas inlet **952** through chamber port **914** of first chamber **903** into and/or around substrate transfer area **932** of chamber port assembly **916**.

In some embodiments, second chamber **905** may additionally or alternatively be configured similarly or identically as first chamber **903** to provide purge gas capability into and/or around substrate transfer area **932** through chamber port **914** of second chamber **905**.

In some embodiments, chamber port assembly **216** may be integrated into a side wall of a transfer chamber. That is, chamber port assembly **216** may not be a separate entity positioned between two chambers, but may be part of a transfer chamber side wall configured to couple directly to another chamber, such as a process or load lock chamber. In some embodiments, chamber port assembly **216** may be an insertable component that fits into an appropriately configured chamber port of the transfer chamber. In some embodiments, a transfer chamber having an integrated chamber port assembly **216** may have a transfer chamber lid that has a gas inlet configured to align with, and be in fluid communication with, gas inlet **552** of lid **440**. In other embodiments, chamber port assembly **216** may not have lid **440**, wherein the transfer chamber lid may be configured to also serve as the lid of chamber port assembly **216**. In some embodiments, the transfer chamber lid may have a removable access port configured above chamber port assembly **216**. In some embodiments, frame insert **444** may be removable and replaceable without having to remove chamber port assembly **216** from the side wall of the transfer chamber.

FIG. **10** illustrates a method **1000** of assembling a chamber port assembly for an electronic device manufacturing system in accordance with one or more embodiments. At process block **1002**, method **1000** may include providing a lid having a gas inlet formed therein and a first gas passageway extending there through, wherein the first gas passageway is in fluid communication with the gas inlet. In some embodiments, the lid may be, e.g., lid **440** having a gas inlet **552** and a gas passageway **557** in fluid communication with gas inlet **552**, as shown in FIGS. **5**A and **5**B.

At process block **1004**, a gas conduit member having a second gas passageway extending there through may be provided. For example, in some embodiments, the gas conduit member may be gas conduit member **442**, which may include a gas passageway **657** extending there through, as shown in FIG. **6**B. In some embodiments, a second gas conduit member **442** may additionally be provided.

At process block **1006**, method **1000** may include providing a frame insert having a third gas passageway extending there through, wherein the frame insert is configured to receive one or more gas nozzles such that the third gas passageway is in fluid communication with the one or more gas nozzles. For example, in some embodiments, the frame insert may be frame insert **444**, the one or more gas nozzles may be gas nozzles **846**, and the third gas passageway may be any one of gas passageways **757***a* or **757***b* of FIG. **7**C or gas passageway **757** of FIG. **7**D.

At process block **1008**, method **1000** may include coupling the lid, gas conduit member, and frame insert such that the first, second, and third gas passageways are in fluid communication with each other. For example, in some embodiments, the lid may be lid **440**, the gas conduit member may be gas conduit member **442**, and the frame insert may be frame insert **444**, all of which may be coupled together as shown and described above in connection with FIGS. **4**A-E. As a result of the coupling, gas passageway **557**, gas passageway **657**, and at least one of gas passageways **757***a*, **757***b*, or **757** may be in fluid communication with each other.

At process block **1010**, method **1000** may include attaching the one or more gas nozzles to the frame insert such that the one or more gas nozzles are configured to direct a flow of gas received at the gas inlet into a substrate transfer area of the chamber port assembly. The one or more gas nozzles may be, e.g., gas nozzles **846**, which may be Vespel® nozzles. The one or more gas nozzles **846** may be mounted to gas outlets **758***a* and **758***b* of frame insert **444** such that a flow of gas received at gas inlet **552** is directed into substrate transfer area **332** of chamber port assembly **216**. In some embodiments, e.g., gas nozzles **846** may be angled at about 32 degrees with respect to a surface of substrate transfer area **332**, as shown in FIG. **8**.

The above process blocks of method **1000** may be executed or performed in an order or sequence not limited to the order and sequence shown and described. For example, in some embodiments, any of process blocks **1002**, **1004**, and **1006** may be performed before, after, or simultaneously with any other of process blocks **1002**, **1004**, and/or **1006**.

Persons skilled in the art should readily appreciate that the embodiments of the invention described herein is susceptible of broad utility and application. Many embodiments and adaptations of the invention other than those described herein, as well as many variations, modifications, and equivalent arrangements, will be apparent from, or reasonably suggested by, the invention and the foregoing description thereof, without departing from the substance or scope of the invention. For example, although described herein as being used primarily between a transfer chamber and a process chamber of an electronic device manufacturing system, chamber port assemblies in accordance with one or more embodiments of the invention may be used between any two chambers and/or structures where contamination of a transferred workpiece by particulate matter is a concern. Accordingly, while the invention has been described herein in detail in relation to specific embodiments, it should be understood that this disclosure is only illustrative and presents examples of the invention and is made merely for purposes of providing a full and enabling disclosure of the invention. This disclosure is not intended to limit the invention to the particular apparatus, devices, assemblies, systems, or methods disclosed, but, to the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention.

The invention claimed is:

1. A chamber port assembly of an electronic device manufacturing system, comprising:

a lid having a gas inlet formed therein and a first gas passageway extending there through, the first gas passageway in fluid communication with the gas inlet;

a gas conduit member having a second gas passageway extending there through, the second gas passageway in fluid communication with the first gas passageway;

a frame insert having a third gas passageway in fluid communication with the second gas passageway; and

one or more gas nozzles coupled to the frame insert and in fluid communication with the third gas passageway, the one or more gas nozzles configured to direct a flow of gas received at the gas inlet into a substrate transfer area, the substrate transfer area configured to receive a substrate as the substrate is transferred through the chamber port assembly from a first chamber to a second chamber.

2. The chamber port assembly of claim **1**, further comprising a second gas conduit member having a fourth gas passageway extending there through, the fourth gas passageway in fluid communication with the first and third gas passageways.

3. The chamber port assembly of claim **1**, further comprising a second gas conduit member having a fourth gas passageway extending there through, the fourth gas passageway in fluid communication with the first gas passageway, wherein the frame insert has a fifth gas passageway in communication with the fourth gas passageway and some of the one or more gas nozzles.

4. The chamber port assembly of claim **1**, further comprising a slit valve mechanism that includes a door, the door having a closed position that abuts the frame insert and seals an opening to the substrate transfer area.

5. The chamber port assembly of claim **1**, wherein the lid is butted against the gas conduit member.

6. The chamber port assembly of claim **1**, wherein the gas conduit member is attached to the frame insert with bolts or screws.

7. The chamber port assembly of claim **1**, wherein the gas conduit member is disposed between the lid and the frame insert.

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